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Heilprin ("Mt. Pelée and the tragedy of Martinique") mentions severe earthquakes in Guatamala, April 18 (*B*) and September 26 (*J*); Finland, April 10–11, and Lake Baikal, April 12 (*A*); Caucasus, April 17 (*B*).

Finally, to turn from the past to the present and future, I have plotted the curve for 1908—a clean page upon which the reader may make his own observations. The Chilapa (Mexico) earthquake and the sudden disappearance of the lake in Oregon will be found to correspond well with the curve. The earthquake registered by the Washington seismograph May 15 and calculated to have occurred at a point about 3,000 miles distant should, if our conclusions are correct, be of volcanic origin, corresponding, as it does, with a luni-solar maximum. From the condition of Etna during 1907 the writer freely predicted an eruption during the present year and, with the aid of the curve, localized it to the spring and summer months. At the time of writing (May) news has come of the initiation of the eruption and it will be interesting to follow its course in connection with the curve and to see if its crises and culminations correspond with the maxima of June 15, July 14 or August 13.

In conclusion the writer desires to state that he fully realizes the crudity and incompleteness at present of this working theory, and his object in bringing it forward at this time, instead of elaborating it by further study and observation, is to stimulate the criticism of others in order that the truth may be the more rapidly advanced. The importance of being able to foreknow the dates in each month when volcanic and seismic manifestations will take place is too obvious to require emphasizing and these data, in connection with research work localized at volcanic and seismic centers, should carry us a long step forward along the line of definitely predicting all such events. During the past two years the writer has often made use of this foreknowledge in planning his visits to volcanoes at interesting times and in absenting himself for preparation work during the in-

tervals of quiet, and it was principally by means of the luni-solar curve that the crisis in the eruption of Stromboli last year was shown to have already occurred when warships had been sent with a view to deporting the 4,000 inhabitants. A resort to this extreme measure was thus rendered unnecessary and this application of our working theory forms a good example of its practical utility.

The present activity of Etna should form a good control and will undoubtedly be of aid in the computing of future curves.

FRANK A. PERRET

THE LOCATION OF EMBRYO-FORMING REGIONS IN THE EGG

THE relation between the visible substances of the egg (nucleus, yolk, pigment, oil, etc.) and the regions of organ-formation has attracted the critical attention of embryologists in recent years. No little diversity of opinion has been expressed as to the rôle played by these substances; whether they represent organ-forming regions, or whether they are only indicia, at most, of more profound changes, is at present the central point of dispute. The separation and stratification of many of these substances by means of the centrifuge has made possible the further analysis of the problem. I wish to put on record here the results of an experiment that bears very directly on the interpretation of the location of organ-forming regions of the egg of *Arbacia*.

As first shown by Lyon, the egg of the sea-urchin may be stratified into four regions by means of the centrifuge. The nucleus is driven into the axis of rotation (secondary egg-axis) and comes to lie near the lighter pole of the egg. Cleavage takes place in most cases at right angles to the stratification. I have been able to demonstrate that the cleavage planes stand in no relation to the original egg axis. Nevertheless, the typical cleavage system generally appears. The primary axis of the embryo, however, bears no fixed relation to the stratification. The fundamental question to settle therefore is what factor determines the location of the embryonic axis.

This point I have been able to determine by means of the "attachment funnel" (micro-pyle?) of the egg-membrane. Boveri has shown that the funnel corresponds to the point of attachment of the egg to the wall of the ovary. It lies opposite to the point of formation of the micromeres in the normal egg, and therefore also opposite to the gastrula pole of the egg. I find that in the centrifuged egg of *Arbacia* the micromeres also appear opposite (or as nearly so as possible) to the attachment funnel, without regard to the stratification of the materials.

Miss G. B. Spooner, working with me, has demonstrated that wherever the micromeres lie on the centrifuged egg there also the gastrulation takes place. Putting together these facts, it is evident that the axis of the embryo derived from the centrifuged egg is the same axis as that of the normal egg. In other words, the location of the nucleus, of the oily matter, of the yolk, and of the pigment of the egg has no determinative influence on the location of the embryonic organs. These visible materials are not organ-forming, nor do they act as initiators of organ formation. Even removal of the nucleus from its normal relations to the egg-axis has no baleful influence on the development.

The results demonstrate that the location of embryo-forming regions is a cytoplasmic and not a nuclear phenomenon. Boveri's classical experiment with dispermic eggs, which he brought forward in order to demonstrate the importance of the nucleus in the early development, receives an entirely different interpretation in the light of these facts. The conclusive demonstration of the location of the primary axis furnished by the experiment given above leads to some far-reaching conclusions concerning the factors of development, and the supposed value of the grosser materials of the egg as organ-forming substances:

1. By means of the centrifuge it is possible to drive the nucleus, the yolk, and pigment granules through embryo-forming materials of the egg without necessarily affecting the polar relations of these materials, and without neces-

sarily injuring them for further development.

2. The displaced nucleus does not return to its original position before cleavage, and its new location determines the position of the first plane of cleavage. There is no essential relation between this plane of division and the planes of the embryo.

3. The embryonic axis is determined in the egg, but whether it is the outcome of an arrangement or gradation of materials which are not affected by the centrifuging, or whether it is due to a hidden structural basis ("organization") can not perhaps be determined from the evidence. When all the facts are taken into consideration, however, the former alternative seems to be more in accord with the results.

4. After centrifuging and before cleavage there is to some extent a remixing of the separated substances, but this partial return shows no evidence of redistribution in the direction of subsequent organ-formation, but is due to movements connected with karyokinesis.

5. The possibility that formative substances are present other than the visible substances here referred to must, of course, be admitted, but such materials are in the egg of the sea-urchin not seriously disturbed by a centrifugal force sufficient to separate the visible substances of the egg. On the other hand, I have found for the egg of the frog that a speed higher than that necessary to separate the grosser materials interferes with the normal development, and in such cases it seems not improbable that more fundamental materials become displaced.

6. The experiments do not show conclusively the origin of the bilaterality of the embryo, but they do show that this is not caused by the stratification, *nor by any particular cleavage plane*, nor by the position of the nucleus.¹ The inference that bilaterality is also "given" in the egg seems therefore most plausible.

T. H. MORGAN

Woods Hole,

August 17, 1908

¹ The evidence on which this statement rests is only partly given in the present communication.